Amendments to the Claims:

This listing of claims will replace all prior versions, and listings, of the claims in the application.

Listing of Claims:

1. (Currently amended) A qubit, comprising:

a multi-terminal Josephson junction ~~having~~ comprising at least two terminals; and

a superconducting loop coupled between two of the at least two terminals; wherein the superconducting loop provides a phase shift and wherein a portion of the phase shift is provided by a phase shifter that interrupts said superconducting loop at a point outside of said multi-terminal Josephson junction.

2. (Currently amended) The qubit of claim 1, wherein the multi-terminal Josephson junction includes at least one constriction junction.

3. (Currently amended) The qubit of claim 1, wherein the multi-terminal Josephson junction includes at least one tunnel junction.

4. (Original) The qubit of claim 3, wherein the tunnel junction is formed by an insulating layer separating two of the at least two terminals.

5. (Currently amended) The qubit of claim 4, wherein the two of the at least two terminals are made from an s-wave superconducting material.

6. (Currently amended) The qubit of claim 1, wherein the multi-terminal Josephson junction includes at least one two-dimensional electron gas structure.

7. (Currently amended) The qubit of claim 6, wherein a two-dimensional electron gas structure in the at least one two-dimensional electron gas structure is an InAs layer deposited on an AlSb substrate.

8. (Currently amended) The qubit of claim 1, wherein

the superconducting loop includes a first portion of ~~a~~ an s-wave superconducting material and a second portion of ~~a~~ an s-wave superconducting ~~material~~ material, and

a portion of the phase shift is produced by a d-wave superconducting material, wherein said d-wave superconducting material is coupled to the first portion through a first normal metal interface and said d-wave superconducting material is coupled to ~~and~~ the second portion through a second normal metal interface ~~interfaces~~, and wherein

~~the~~ a portion of the phase shift ~~being~~ is determined by ~~the~~ an angle between the first normal metal interface and the second normal metal interface and crystallographic directions in the d-wave superconducting material.

9. (Currently amended) The qubit of claim 1, wherein

the superconducting loop includes a first portion of ~~a~~ an s-wave superconducting material and a second portion of ~~a~~ an s-wave superconducting material, and wherein a portion of the phase shift is determined by a difference in (i) a crystallographic direction of a first d-wave superconducting material and (ii) a crystallographic direction of a second d-wave superconducting material across a grain boundary interface between said first d-wave superconducting material and said second d-wave superconducting material, wherein

~~produced by a~~ said first d-wave superconducting material is coupled through a normal metal to the first portion of said s-wave superconducting material and ~~a~~

said second d-wave superconducting material is coupled through a second normal metal to the second portion of said s-wave superconducting material~~, the portion of the phase shift being determined by the difference in crystallographic directions in a grain boundary interface between the first d-wave superconducting material and the second d-wave superconducting material~~.

10. (Currently amended) The qubit of claim 9, wherein the first d-wave superconducting material is formed on a first portion of a bi-crystal substrate and the second d-wave superconducting material ~~are~~ is formed on a second portion of said bi-

crystal substrate ~~insulating crystals~~.

11. (Currently amended) The qubit of claim 9, wherein the s-wave superconducting material is chosen from ~~a~~ the group consisting of ~~Aluminum, Niobium, Lead, Mercury, and Tin~~ aluminum, niobium, lead, mercury, and tin.

12. (Original) The qubit of claim 9, wherein the d-wave superconducting material is $YBa_2Cu_3O_{7-x}$.

13. (Currently amended) The qubit of claim 9 ~~10~~, wherein the qubit is formed on a substrate that is made of a material selected ~~the insulating crystals can be chosen~~ from the group consisting of ~~Strontium Titanate, Sapphire, Cerium Oxide, and Magnesium Oxide~~ strontium titanate, sapphire, cerium oxide, and magnesium oxide.

14. (Currently amended) The qubit of claim 1, wherein the phase shifter is ~~a portion of the phase shift is produced by~~ a ferromagnetic junction.

15. (Original) The qubit of claim 14, wherein the superconducting loop includes a first portion and a second portion, the first portion and the second portion being coupled by the ferromagnetic junction.

16. (Currently amended) The qubit of claim 15, wherein the first portion and the second portion are each made of an s-wave superconducting material.

17. (Currently amended) The qubit of claim 16, wherein the s-wave superconducting material is chosen from the group consisting of ~~Aluminum, Niobium, Lead, Mercury, and Tin~~ aluminum, niobium, lead, mercury, and tin.

18. (Currently amended) The qubit of claim 16, wherein the ferromagnetic junction is formed by copper or ~~Nickel~~ nickel sandwiched between the first portion and the second portion.

19. (Currently amended) The qubit of claim 16, wherein the ferromagnetic junction is

~~provided~~ formed by implanting a ferromagnetic material into the s-wave superconducting material between the first portion and the second portion.

20. (Currently amended) The qubit of claim 1, wherein the superconducting loop is formed from a d-wave superconducting material having at least one grain boundary and wherein a portion of the phase shift is formed by said at least one grain ~~boundaries~~ boundary ~~in the d-wave superconducting material of the superconducting loop~~.

21. (Currently amended) The qubit of claim 1, wherein the at least two terminals includes four terminals and the multi-terminal Josephson junction includes a four-terminal constriction junction which couples each of the four terminals.

22. (Currently amended) The qubit of claim 1, wherein the at least two terminals includes four terminals and the multi-terminal Josephson junction includes a constriction junction coupling two of the four terminals, a first tunneling junction coupling a third of the four terminals to one of the two terminals coupled by the constriction junction, and a second tunneling junction coupling a fourth of the four terminals to one of the two terminals coupled by the constriction junction.

23. (Currently amended) The qubit of claim 22 wherein each of the first tunneling junction and the second tunneling junction ~~are~~ is arranged ~~to be~~ substantially parallel with one of the two terminals coupled together by the constriction junction.

24. (Currently amended) The qubit of claim 1, wherein the at least two terminals includes four terminals and the multi-terminal Josephson junction includes a tunneling junction coupling a first of the four terminals with a second of the four terminals, a first constriction junction coupling the second of the four terminals with a third of the four terminals, and a second constriction junction coupling the third of the four terminals with a fourth of the four terminals.

25. (Original) The qubit of claim 24 wherein the tunneling junction is substantially parallel with the second of the four terminals.

26. (Original) The qubit of claim 1, wherein the at least two terminals includes four terminals coupled by a two-dimensional electron gas structure.

27. (Currently amended) The qubit of claim 1, wherein the at least two terminals includes four terminals, three of which are coupled by a two-dimensional electron gas structure and the fourth of which is coupled to one of the three with a constriction junction.

28. (Currently amended) The qubit of claim 1, wherein the at least two terminals includes four terminals, three of which are coupled by a two-dimensional electron gas structure and the fourth of which is coupled to one of the three with a tunneling junction.

29. (Currently amended) The qubit of claim 1, wherein the multi-terminal Josephson junction includes a constriction junction coupling each of the at least two terminals.

30. (Currently amended) The qubit of claim 1, wherein the multi-terminal Josephson junction includes a constriction junction coupling a first terminal with a second terminal and at least one tunneling junction coupling at least one other terminal to the first terminal and the second terminal.

31. (Currently amended) The qubit of claim 1, wherein the multi-terminal Josephson junction includes an electron gas structure coupling each of the at least two terminals.

32. (Currently amended) The qubit of claim 1, wherein the multi-terminal Josephson junction is a three-terminal junction.

33. (Currently amended) The qubit of claim 1, wherein the multi-terminal Josephson junction is a four-terminal junction.

34. (Currently amended) The qubit of claim 1, wherein the multi-terminal Josephson junction is a five-terminal junction.

35. (Currently amended) The qubit of claim 1, wherein the multi-terminal Josephson junction is a six-terminal junction.

36. (Currently amended) The qubit of claim 1, wherein the multi-terminal Josephson junction includes more than six terminals.

37. (Currently amended) The qubit of claim 1, wherein the multi-terminal Josephson junction is ~~capable of~~ configured to symmetrically ~~transporting~~ transport current.

38. (Currently amended) The qubit of claim 1, wherein the multi-terminal Josephson junction is ~~capable~~ configured to ~~of~~ asymmetrically ~~transporting~~ transport current.

39. (Currently amended) A qubit, comprising:

means for coupling a plurality of terminals;

means for forming a superconducting loop between two of the plurality of terminals;

means for providing a phase shift in the superconducting loop, wherein a portion of the phase shift is provided by a phase shifter that interrupts said superconducting loop at a point in said superconducting loop other than the coupling of said two of the plurality of terminals.

40. (Currently amended) The qubit of claim 39, wherein the means for coupling ~~a~~ the plurality of terminals includes a two-dimensional electron gas junction.

41. (Currently amended) The qubit of claim 39, wherein the means for coupling ~~a~~ the plurality of terminals includes a tunnel junction.

42. (Currently amended) The qubit of claim 39, wherein the means for coupling ~~a~~ the plurality of terminals includes a constriction junction.

43. (Currently amended) The qubit of claim 39, wherein the means for providing the ~~a~~ phase shift includes providing a d-wave superconductor material coupled into the

superconducting loop.

44. (Currently amended) The qubit of claim 39, wherein the means for providing the ~~a~~ phase shift includes a grain boundary between two lattice-mismatched d-wave superconducting materials.

45. (Currently amended) The qubit of claim 39, wherein the means for providing ~~a~~ the phase shift includes a ferromagnetic junction.

46. (Currently amended) A qubit array, comprising: a plurality of qubits, at least one qubit in ~~of~~ the plurality of qubits comprising:

a multi-terminal Josephson junction ~~with~~ comprising at least two terminals;

~~coupled to form~~ a superconducting loop coupled between two of the at least two terminals, the superconducting loop providing a phase shift and wherein a portion of the phase shift is provided by a phase shifter that interrupts said superconducting loop at a point outside of said multi-terminal Josephson junction.

47. (Currently amended) The qubit array of claim 46, wherein the multi-terminal Josephson junction includes at least one constriction junction.

48. (Currently amended) The qubit array of claim 46, wherein the multi-terminal Josephson junction includes at least one tunnel junction.

49. (Currently amended) The qubit array of claim 48, wherein the tunnel junction is formed by an insulating layer separating two of the at least two terminals.

50. (Currently amended) The qubit array of claim 49, wherein the two of the at least four terminals are made of an s-wave superconducting material.

51. (Currently amended) The qubit array of claim 46, wherein the multi-terminal Josephson junction includes at least one two-dimensional electron gas structure.

52. (Currently amended) The qubit array of claim 51, wherein the at least one two-

dimensional electron gas structure is an InAs layer deposited on an AlSb substrate.

53. (Currently amended) The qubit array of claim 46, wherein the superconducting loop includes a first portion of ~~a~~ an s-wave superconducting material and a second portion of ~~a~~ an s-wave superconducting material and wherein a portion of the phase shift is produced by a d-wave superconducting material coupled to the first portion and the second portion through normal metal interfaces, the portion of the phase shift being determined by the angle between the normal metal interface and a crystallographic ~~directions~~ direction in the d-wave superconducting material.

54. (Currently amended) The qubit array of claim 46, wherein the superconducting loop includes a first portion of a s-wave superconducting material and a second portion of a s-wave superconducting material and wherein a portion of the phase shift is produced by a first d-wave superconducting material coupled through a normal metal to the first portion and a second d-wave superconducting material coupled through a second normal metal to the second portion, the portion of the phase shift being determined by the difference in crystallographic directions in a grain boundary interface between the first d-wave superconducting material and the second d-wave superconducting material.

55. (Currently amended) The qubit array of claim 54, wherein the first d-wave superconducting material and the second d-wave superconducting material are formed on respective insulating crystals.

56. (Currently amended) The qubit array of claim 54, wherein the s-wave superconducting material is chosen from ~~a~~ the group consisting of ~~Aluminum, Niobium, Lead, Mercury, and Tin~~ aluminum, niobium, lead, mercury, and tin.

57. (Currently amended) The qubit array of claim 54, wherein the d-wave superconducting material is $YBa_2Cu_3O_{7-x}$.

58. (Currently amended) The qubit array of claim 55, wherein the insulating crystals ~~can be~~ are chosen from the group consisting of ~~Strontium Titanate, Sapphire, Cerium~~

~~Oxide, and Magnesium Oxide~~ strontium titanate, sapphire, cerium oxide, and magnesium oxide.

59. (Currently amended) The qubit array of claim 46, wherein the phase shifter in the superconducting loop of said at least one of the plurality of qubits is ~~a portion of the phase shift is produced by~~ a ferromagnetic junction.

60. (Currently amended) The qubit array of claim 59, wherein the superconducting loop includes a first portion and a second portion, the first portion and the second portion being coupled by the ferromagnetic junction.

61. (Currently amended) The qubit array of claim 60, wherein the first portion and the second portion are each made of an s-wave superconducting material.

62. (Currently amended) The qubit array of claim 61, wherein the s-wave superconducting material is chosen from the group consisting of ~~Aluminum, Niobium, Lead, Mercury, and Tin~~ aluminum, niobium, lead, mercury, and tin.

63. (Currently amended) The qubit array of claim 61, wherein the ferromagnetic junction is formed by copper or ~~Nickel~~ nickel sandwiched between the first portion and the second portion.

64. (Currently amended) The qubit array of claim 61, wherein the ferromagnetic junction is provided by implanting a ferromagnetic material into the s-wave superconducting material between the first portion and the second portion.

65. (Currently amended) The qubit array of claim 46, wherein the superconducting loop is formed from a d-wave superconducting material and wherein a portion of the phase shift is formed by grain boundaries in the d-wave superconducting material of the superconducting loop.

66. (Currently amended) The qubit array of claim 46, wherein the multi-terminal Josephson junction couples at least four terminals, two of the at least four terminals

being coupled to the superconducting loop, at least one of the remaining two terminals being coupled to a multi-terminal Josephson junction of another of the plurality of qubits to form a series connection.

67. (Currently amended) The qubit array of claim 46, wherein the multi-terminal Josephson junction of said at least one qubit in said plurality of qubits couples at least six terminals and wherein ~~the plurality of qubits includes a first superconducting loop and a second superconducting loop, the~~ a first superconducting loop ~~being~~ is coupled to a first pair of the six terminals and ~~the~~ a second superconducting loop ~~being~~ is coupled to a second pair of the six terminals.

68. (Currently amended) The qubit array of claim 67, wherein a third pair of the six terminals is coupled to a current source.

69. (Currently amended) The qubit array of claim 67, wherein the second superconducting loop is further coupled to a first pair of terminals from a ~~second one~~ a multi-terminal junction of a different qubit in said plurality of qubits.

70. (Currently amended) The qubit array of claim 67, wherein at least one of the six terminals is coupled to a coupling junction, the coupling junction being coupled to a junction which is coupled to at least one superconducting loop.

71. (Currently amended) The qubit array of claim 46, wherein at least two of the plurality of qubits share a shared multi-terminal junction.

72. (Currently amended) The qubit array of claim 71, wherein the shared multi-terminal Josephson junction is a six-terminal junction.

73. (Currently amended) The qubit array of claim 46, wherein at least two of the plurality of qubits include a superconducting loop and at least two of the superconducting loops are switchably coupled with an entanglement junction.

74. (Currently amended) The qubit array of claim 73, wherein the entanglement

junction includes a plate which can capacitively couple a voltage to a coupling junction joining the at least two superconducting loops.

75. (Currently amended) The ~~entanglement junction~~ qubit array of claim 74, wherein the plate is a structure that allows capacitive coupling of a voltage to the coupling junction.

76. (Currently amended) The qubit array of claim 74, wherein the voltage determines whether the coupling junction is open or closed.

77. (Currently amended) The qubit array of claim 76, wherein the coupling junction is a two dimensional electron gas.

78. (Currently amended) The qubit array of claim 77, wherein the entanglement junction further controls the coupling of at least one of the at least two superconducting loops with the multi-terminal junction.

79. (Currently amended) The qubit array of claim 77, wherein the coupling junction includes a tunnel junction.

80. (Currently amended) An array of qubits~~, comprising~~ comprising:

a plurality of qubits, each qubit ~~of~~ in the plurality of qubits ~~including~~ including:

~~a superconducting loop coupled to~~ a multi-terminal Josephson junction comprising at least two terminals;

~~, the~~ a superconducting loop coupled between two of the at least two terminals, the superconducting loop providing a phase shift and wherein a portion of the phase shift is provided by a phase shifter that interrupts said superconducting loop at a point outside of said multi-terminal Josephson junction; and

an entanglement junction that ~~coupling~~ couples a superconducting ~~loops~~ loop of a first qubit in said plurality of qubits to a superconducting loop of a second qubit in said ~~of two qubits of the~~ plurality of qubits.

81. (Currently amended) The ~~qubit~~ array of qubits of claim 80, wherein the multi-terminal Josephson junction of at least one of the qubits in the plurality of qubits includes at least one constriction junction.

82. (Currently amended) The ~~qubit~~ array of qubits of claim 80, wherein the multi-terminal Josephson junction of at least one of the qubits in the plurality of qubits includes at least one tunnel junction.

83. (Currently amended) The ~~qubit~~ array of qubits of claim 80, wherein the multi-terminal Josephson junction of at least one of the qubits in the plurality of qubits includes at least one two-dimensional electron gas structure.

84. (Currently amended) The ~~qubit~~ array of qubits of claim 80, wherein

the superconducting loop of at least one of the qubits in the plurality of qubits includes a first portion of ~~a~~ an s-wave superconducting material and a second portion of ~~a~~ an s-wave superconducting material and wherein a portion of a phase shift is produced by a d-wave superconducting material coupled to the first portion and the second portion through normal metal interfaces, the portion of the phase shift being determined by the angle between the normal metal interface and a crystallographic ~~directions~~ direction in the d-wave superconducting material.

85. (Currently amended) The ~~qubit~~ array of qubits of claim 80, wherein the superconducting loop of at least one of the qubits in the plurality of qubits includes a first portion of ~~a~~ an s-wave superconducting material and a second portion of ~~a~~ an s-wave superconducting material and wherein a portion of a phase shift is produced by a first d-wave superconducting material coupled through a normal metal to the first portion and a second d-wave superconducting material coupled through a second normal metal to the second portion, the portion of the phase shift being determined by the difference in crystallographic directions in a grain boundary interface between the first d-wave superconducting material and the second d-wave superconducting material.

86. (Currently amended) The ~~qubit~~ array of qubits of claim 80, wherein ~~the superconducting loop of at least one of the qubits in the plurality of qubits provides a phase shift,~~ a portion of the phase shift ~~being~~ in a qubit in the plurality of qubits is produced by a ferromagnetic junction.

87. (Currently amended) The ~~qubit~~ array of qubits of claim 80, wherein the superconducting loop of at least one of the qubits in the plurality of qubits is formed from a d-wave superconducting material and wherein a portion of ~~a~~ the phase shift is formed by grain boundaries in the d-wave superconducting material of the superconducting loop.

88. (Currently amended) The ~~qubit~~ array of qubits of claim 80, wherein the entanglement junction comprises:

a multi-terminal Josephson junction coupled between the superconducting ~~loops~~ loop of said first qubit and the superconducting loop of said second qubit ~~of two of the plurality of qubits~~; and

a plate proximate the multi-terminal Josephson junction ~~to capacitively couple a potential into the coupling junction~~.

89 (Currently amended) The array of qubits of ~~entanglement junction of~~ claim 88, wherein the plate is a structure that allows a voltage to be capacitively coupled to the multi-terminal Josephson junction coupled between the superconducting loop of said first qubit and the superconducting loop of said second qubit ~~coupling junction~~.

90. (Currently amended) The array of qubits of claim 88, wherein the multi-terminal Josephson junction of the entanglement junction includes a two-dimensional electron gas.

91. (Currently amended) The array of qubits of claim 88, wherein the multi-terminal Josephson junction of the entanglement junction is separated from, and not part of, ~~the portion of~~ the superconducting loop of said first qubit and the superconducting loop of said second qubit ~~superconducting loops that the multi-terminal junction couples where the flux is maintained~~.

92. (Currently amended) The array of qubits of claim 91, wherein quantum states on the first qubit and the second qubit ~~superconducting loops of the two superconducting loops of the two qubits~~ are entangled or not entangled in response to voltages applied to the plate of the entanglement junction.

93. (Currently amended) The array of qubits of claim 92, wherein the quantum states are entangled ~~if~~ when no voltage is applied to the plate and not entangled ~~if~~ when a voltage is applied to the plate.